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Applicants: Masahisa Kobayashi  
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## BUS POWER-SUPPLY DEVICE AND NODE

### BACKGROUND OF THE INVENTION

#### FIELD OF THE INVENTION

5           The present invention relates to a node connected to a serial bus and a bus power-supply device constituting the node suitable for IEEE-1394 Standards.

#### DESCRIPTION OF THE RELATED ART

10           In IEEE-1394 Standard information networks, as many as 63 of various nodes such as an audio visual apparatuses (AV apparatus) and a repeater, in addition to an information processing apparatus, can be connected on the same serial bus.

15           Then, an IEEE-1394 Standard serial bus includes a signal line for propagating a digital serial signal and a power-supply line. A node connected to the serial bus is therefore allowed to receive a supply of power from other nodes through a power-supply line to operate. As a result, IEEE-1394 Standard information networks have an  
20           advantage that not every node needs to be provided with an individual power source such as a commercial power-supply system. Hereinafter, an inherent power source each node individually has is also called "internal power source" for convenience' sake. On the other hand,  
25           a power source which is a direct-current (DC) voltage applied from other node through a serial bus is also

called "bus power source".

Here, one example of IEEE-1394 Standard information networks is shown in Fig. 5. Fig. 5 schematically shows an example in which five nodes 101, 102, 103, 104 and 105 are connected to one bus line 110. In this example, since the node 101 and the node 105 are supplied with a power-supply voltage from a commercial power-supply system, also to other nodes 102 to 104, power is supplied from the node 101 or the node 105 through the bus line 110. The nodes 102 to 104 therefore need not to be provided with an internal power source.

Next, description will be made of one node connected to a conventional IEEE-1394 Standard serial bus.

<sup>15</sup> ~~Although nodes, except a repeater, in general,~~  
have various components including a link layer in addition to main components such as a bus power-supply circuit, description will be made in the following with reference to each drawing having illustration only of main components for making the present invention be easy to understand. <sup>17</sup>

Fig. 6 shows an example of a structure of a node defined by IEEE-1394-1995. As shown in Fig. 6, a node 100c includes a power-supply circuit 2, a DC-DC converter 5 and a physical (PHY) layer 6 which are connected to a serial bus through two connectors 8 and 9.

The connectors 8 and 9 include power-supply

terminals 81 and 91 and signal terminals 82 and 92, respectively. To the power-supply terminals 81 and 91, a DC voltage is applied from a power-supply line of the serial bus. Furthermore, in the node 100c, the power-supply terminals 81 and 91 of the two connectors 8 and 9 are conductive to each other. The node 100c is therefore allowed to relay a DC voltage applied through the serial bus to other nodes.

On the other hand, to/from the signal terminals 82 and 92, signals are input/output from/to a signal line of the serial bus. Then, a signal input through one signal terminal of the two signal terminals 82 and 92 is subjected to data resynchronization by a local clock at the physical layer 6 and then output through the other signal terminal.

This arrangement enables relay of transmission and reception of signals to and from nodes not adjacent to each other on the serial bus line.

The power-supply circuit 2 is a means for supplying a DC voltage to the physical layer 6 and the serial bus which transmit and receive signals. The power-supply circuit 2 therefore converts a power-supply voltage input through a power-supply voltage input terminal 1 into a DC voltage suitable for the supply to the serial bus and outputs the DC voltage. The output DC voltage is applied to the power-supply terminals 81 and 91 through a diode 7 for preventing reverse current and

To the DC-DC converter 5, a DC voltage is applied not only from the power-supply circuit 2 but also from the serial bus through the power-supply terminal 81.

The node 100c is thus structured such that the physical layer 6 can be driven by either of a DC voltage applied from the bus power source through the serial bus and a DC voltage applied by the internal power source through the power-supply circuit 2.

As a result, there occurs a case where DC voltages applied to the serial bus from power-supply circuits 2 of various nodes connected to each other through the serial bus differ with the nodes. In this case, the highest DC voltage will be applied to the entire serial bus. A node which supplies the highest voltage should supply power to physical layers of all the nodes on the serial bus regardless whether the other

nodes are supplied or not supplied with power from internal power supply systems.

In the information network using a serial bus shown in Fig. 5, in a case where both of the first and the second nodes 101 and 102 are supplied with a power supply voltage, when a supply voltage to the first node 101 is higher than that to the second node 102, the first node 101 should supply power also to the remaining nodes including the second node 102. In other words, although the second node 102 has an internal power source, power will be supplied from the first node 101 to the second node 102.

In order to solve this problem "IEEE-1394a Draft Standard" proposes an improvement in the structure of a bus power-supply device of a node.

Here, Fig. 7 shows an example of an improved structure of a node 100d. As illustrated in Fig. 7, although the improved node 100d has the same components as those of the above-described node 100c, it has different wiring paths connecting a power-supply circuit 2, a DC-DC converter 5 and two power-supply terminals 81 and 91.

More specifically, in the node 100d, a DC voltage output from the power-supply circuit 2 is applied to the power-supply terminal 81 through a diode 7 for preventing reverse current and to the power-supply terminal 91 as well through a diode 14.

On the other hand, a DC voltage applied through the power-supply terminal 81 is applied to the DC-DC converter 5 through a diode 11, while a DC voltage applied through the power-supply terminal 91 is applied to the DC-DC converter 5 through a diode 12.

As a result, at the node 100d, on the two wiring paths connecting the power-supply terminals 81 and 91, two diodes should be disposed in series in opposite directions to each other without fail. In the node 100d, therefore, no direct current will flow between the power-supply terminals 81 and 91.

On the path from the power-supply terminal 81 to the power-supply terminal 91 through the diodes 11 and 12, for example, current directing from the power-supply terminal 81 to the power-supply terminal 91 will not flow due to the diode 12 and current in the opposite direction will not flow due to the diode 11. On the path from the power-supply terminal 81 to the power-supply terminal 91 through the diodes 7 and 14, current directing from the power-supply terminal 81 to the power-supply terminal 91 will not flow due to the diode 7 and current in the opposite direction will not flow due to the diode 14.

The improved node 100d is thus structured such that a DC voltage is applied only to its adjacent node among all the nodes connected by the serial bus. It is accordingly possible to reduce the volume of power

supply required of a node having the highest DC voltage.

With the improved node, however, no direct current flows between the power-supply terminals 81 and 91, so that relay of a DC voltage applied through the serial bus to other nodes is impossible. There accordingly occurs a problem that no DC voltage can be applied to other nodes than an adjacent node. In other words, the node has a restriction that to a node having no internal power-supply system, its adjacent node should supply power.

In the network shown in Fig. 5, for example, to the second node 102 having no internal power source, a DC voltage is applied from its adjacent first node 101 through the serial bus. To the fourth node 104, a DC voltage is applied from its adjacent fifth node 105 through the serial bus.

To the third node 103, however, a DC voltage will be applied from nowhere because the third node 103 and its adjacent nodes have no supply of a power-supply voltage. Therefore, the physical layer of the third node 103 will not be driven and the third node 103 is accordingly not allowed to relay a signal. As a result, signal transmission and reception is not allowed between the first and the second nodes 101 and 102 and the fourth and the fifth nodes 104 and 105. In other words, an information network can not be established using a serial bus.



Moreover, even in the improved node, when a power-supply voltage is supplied to both of nodes adjacent to each other, a highest DC voltage will be applied to both the nodes. As a result, there occurs a problem that one node which outputs a higher DC voltage should supply power also to the other node even if the other node has an internal power source.

#### SUMMARY OF THE INVENTION

An object of the present invention, which is directed to solving the above-described problems, is to provide a bus power-supply device enabling relay of a DC voltage applied from a serial bus to be ensured and when a node has an internal power source, enabling application of a DC voltage from other node to a physical layer to be prevented, and node using such a device.

According to one aspect of the invention, a bus power-supply device structured to supply power from a power-supply voltage of a node to a serial bus connected to the node through a physical layer and a plurality of connectors conductive to each other of the node, wherein

when none of a power-supply voltage of the node is supplied, a DC voltage is supplied from the serial bus to the physical layer, and

when the power-supply voltage is supplied, a path for supplying a DC voltage from the serial bus to the

physical layer is cut off to supply a DC voltage from the power-supply voltage to the physical layer.

Thus, according to a bus power-supply device of the present invention, since power-supply terminals of a plurality of connectors are conductive to each other, relay of a DC voltage applied through a serial bus to other node is possible. Application of a DC voltage to other nodes than an adjacent node is accordingly possible.

Furthermore, the device according to the present invention is structured such that a DC voltage is supplied from a serial bus when no power-supply voltage is supplied, while at the supply of a power-supply voltage, a DC voltage is supplied from the power-supply voltage. Thus, when a node has an internal power source, cut-off of a path for supplying a DC voltage from the serial bus to a physical layer prevents application of a DC voltage from other node to the physical layer. To the node having an internal power source, therefore, no power will be supplied from other nodes through the serial bus. As a result, the volume of power supply required of a node having the highest DC voltage can be reduced as much as that of the node having the internal power source.

In the preferred construction, the bus power-supply device comprises voltage detection means for detecting the power-supply voltage being supplied or not

being supplied, and selection means for supplying a DC voltage coming from the serial bus to the physical layer when the voltage detection means is yet to detect supply of a power-supply voltage and cutting off the path for supplying a DC voltage from the serial bus to the physical layer to supply a DC voltage from the power-supply voltage to the physical layer when the voltage detection means detects supply.

Thus, with a voltage detection means and a selection means provided, supply of a power supply voltage can be detected by the voltage detection means and switching of a DC voltage source to be supplied to a physical layer at the time of application of a power supply voltage and at the time of non-application thereof can be made by the selection means.

In another preferred construction, the bus power-supply device comprises a comparator as the voltage detection means.

With the foregoing structure, comparison between a power-supply voltage or an output voltage of the power-supply circuit and a reference voltage enables detection of supply of a power-supply voltage with ease.

In another preferred construction, the bus power-supply device comprises as the selection means a first path for supplying power from the power-supply voltage to the physical layer, and a second path for supplying power coming from the serial bus to the physical layer,

when power is supplied from the power-supply voltage, the second path is cut off.

A first path may be cut off or rendered conductive at the time of non-application of a power-supply voltage. In a case where the path is rendered conductive, it is necessary to provide such a means for preventing reverse current as a diode on the first path.

Thus, provision of a semiconductor switch such as a transistor as the selection means enables switching and selection of a path by conduction and cut-off of the semiconductor switch to be controlled with ease by an output voltage of the voltage detection means.

In another preferred construction, the bus power-supply device comprises a relay element as the voltage

detection means and the selection means.

Supplying a power-supply voltage to a relay element enables displacement of a contact point of relay. Then, making use of the contact point for the switching of a DC voltage source applied to the physical layer allows the relay element to be used as the voltage detection means and the selection means.

In another preferred construction, the bus power-supply device comprises a power-supply circuit for converting the power-supply voltage into a DC voltage for the serial bus and outputting the DC voltage, voltage conversion means for converting a DC voltage output from the power-supply circuit into a DC voltage for the physical layer, voltage detection means for detecting the power-supply voltage being supplied or not being supplied to the power-supply circuit, and selection means for supplying a DC voltage applied from the serial bus to the voltage conversion means when the power-supply voltage is not supplied to the power-supply circuit and cutting off a path for supplying a DC voltage from the serial bus to the voltage conversion means to supply an output of the power-supply circuit to the voltage conversion means when the power-supply voltage is supplied.

Thus, with a power-supply circuit, a voltage conversion means, a voltage detection means and a selection means provided, a DC voltage to be suitably

5       Therefore, a DC voltage different from that to be  
applied to the serial bus can be applied to the physical  
layer.

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In another preferred construction, the bus power-supply device further comprises as the selection means a first path for supplying power from the power-supply voltage to the physical layer, and a second path for supplying power coming from the serial bus to the physical layer, wherein

when power is supplied from the power-supply voltage, the second path is cut off,

the voltage detection means detects the power-supply voltage being supplied or not being supplied by detecting an output voltage of the power-supply circuit.

In another preferred construction, the bus power-supply device comprises as the selection means

a first path for supplying power from the power-supply voltage to the physical layer, and a second path for supplying power coming from the serial bus to the physical layer, wherein

when power is supplied from the power-supply voltage, the second path is cut off, and

the selection means is structured by a semiconductor switch.

In another preferred construction, the voltage detection means detects the power-supply voltage being supplied or not being supplied by detecting an output voltage of the power-supply circuit, and

the selection means is structured by a semiconductor switch.

According to another aspect of the invention, a node connected to a serial bus, comprises

a plurality of connectors connected to the serial bus each having a power-supply terminal to which a DC voltage is applied from other nodes and a signal terminal to and from which a signal from other nodes is input and output,

a physical layer for outputting a signal input through a signal terminal of one connector from a signal terminal of the other connector, and

a bus power-supply device structured to supply power from a power-supply voltage to the physical layer and the serial bus, wherein

power-supply terminals of the plurality of connectors are rendered conductive to each other,

the bus power-supply device

supplies a DC voltage from the serial bus to the physical layer through the power-supply terminal when none of a power-supply voltage of the node is supplied, and

cuts off a path for supplying a DC voltage from the serial bus to the physical layer to supply a DC voltage from the power-supply voltage to the physical layer when the power-supply voltage is supplied.

Thus, the node according to the present invention enables relay of a DC voltage applied through the serial bus to other nodes, as well as enabling application of a



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when power is supplied from the power-supply

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Other objects, features and advantages of the present invention will become clear from the detailed description given herebelow.

### BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be understood more fully from the detailed description given herebelow and

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~~The preferred embodiment of the present invention~~

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further includes a bus power-supply device 10. The bus power-supply device 10, being supplied with no power-supply voltage, supplies a DC voltage from a bus power source to the physical layer 6 through a serial bus and when being supplied with a power-supply voltage as an internal power source from a power-supply voltage input terminal 1, applies a DC power source to the serial bus, as well as supplying a DC voltage from the internal power source to the physical layer 6 as required.

In order to realize such functions, the bus power-supply device 10 includes a power-supply circuit 2, a voltage detection unit 3, a selector 4 as a selection means, and a DC-DC converter 5 as a voltage conversion means. Then, the power-supply circuit 2 and power-supply terminals 81 and 91 of the connectors are connected through a diode for preventing reverse current of electric currents from the power-supply terminals 81 and 91 to the power-supply circuit 2.

The power-supply circuit 2 converts a power-supply voltage of a commercial voltage (e.g. AC 100 V) applied to the power-supply voltage input terminal 1 into a DC voltage for serial bus and outputs the converted voltage. In the present embodiment, the power-supply circuit 2 outputs, for example, 24V DC voltage, as a DC voltage within a range from DC + 20V to DC + 33V meeting "IEEE-1394a Draft Standard".

The DC-DC converter 5 converts a DC voltage

output from the power-supply circuit into a DC voltage for physical layer. In the present embodiment, the DC-DC converter 5 is structured so as to cope with a DC voltage within a range from DC + 8V to DC + 40V which meets the IEEE-1394 Standard. Then, the DC-DC converter 5 converts the applied DC voltage into a DC voltage, for example, of 3.3 V for physical layer.

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~~In addition, the voltage detection unit 3 detects supply/non-supply of a power-supply voltage from the power-supply voltage input terminal 1 to the power-supply circuit 2. In the present embodiment, the voltage detection unit 3 detects an output voltage of the power-supply circuit 2 to detect supply/non-supply of a power-supply voltage. This arrangement enables determination that no power-supply voltage is supplied to be made also when the power-supply circuit 2 fails.~~ *A4*

Then, the selector 4 is a means for switching a DC voltage source to be applied to the physical layer 6 through the DC-DC converter 5. Then, when no power-supply voltage is supplied to the power-supply circuit 2, the selector 4 supplies a DC voltage applied from the bus power source through the serial bus to the physical layer 6. On the other hand, when a power-supply voltage from the internal power source is supplied to the power-supply circuit 2, the selector 4 cuts off the path for supplying a DC voltage from the serial bus to the physical layer 6 and supplies the output of the power-

supply circuit 2 to the physical layer 6.

Thus, the node according to the first embodiment enables relay of a DC voltage applied from the serial bus to other nodes, as well as enabling application of a DC voltage to the physical layer from other nodes to be prevented by cutting off a path for supplying a DC voltage from the serial bus to the physical layer when the node has an internal power source. It is accordingly possible to reduce the volume of power supply required of a node having the highest DC voltage on the network as much as that of a node having an internal power source among the nodes according to the present invention.

~~[Second Embodiment]~~

Next, a second embodiment of the present invention will be described with reference to Fig. 2.

Fig. 2 is a block diagram showing a node 100a, particularly, for explaining a structure of a bus power-supply device 10a constituting the node 100a according to the second embodiment. As shown in Fig. 2, the node 100a of the second embodiment includes a transistor 41 and a diode 13 as a selector. In the second embodiment, the same components as those of the first embodiment are given the same reference numerals and no detailed description is made thereof.

~~A first electrode 41a of the transistor 41 is connected to power-supply terminals 81 and 91. A second~~

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~~electrode 41b of the transistor 41 is connected to a physical layer 6 through a DC-DC converter 5 and to a power-supply circuit 2 as well through the diode 13. The diode 13 is inserted for preventing reverse current from the power-supply terminals 81 and 91 to the power-supply circuit 2 on the power-supply voltage side.~~ *AD*

Furthermore, a control electrode 41c of the transistor 41 is connected to a voltage detection unit 3. Accordingly, an output voltage of the voltage detection unit 3 enables path switching and selection by conduction and cut-off of the transistor 41 to be controlled with ease.

More specifically, in the second embodiment, a first path A for supplying power from a power-supply voltage to the physical layer 6 through the power-supply circuit 2 and a second path B for supplying power from the serial bus to the physical layer 6 through the transistor 41 are provided.

In Fig. 2, the first path and the second path are schematically illustrated by broken lines A and B along the actual paths.

Then, when power is supplied from the power-supply voltage, the second path B is cut off by the transistor 41. In other words, the transistor 41 enables control of application/non-application of a DC voltage from the serial bus to the physical layer 6 with ease.

As a result, cutting off the second path B at the



time of supply of a power-supply voltage leads to prevention of application of a DC voltage from the serial bus to the physical layer. To a node having an internal power source, accordingly, no power will be supplied from other nodes through the serial bus. As a result, it is possible to reduce the volume of power supply required of a node having the highest DC voltage on the network as much as that of a node having an internal power source among the nodes according to the present invention.

Next, description will be made of an example of a structure of the voltage detection unit 3 in the second embodiment with reference to Fig. 3.

The voltage detection unit 3 illustrated in Fig. 3 includes a comparator 31. The comparator 31 compares a reference voltage (e.g. 5V) applied to a reference voltage input terminal 30 and an output voltage of the power-supply circuit 2. Then, the comparator 31, when the output voltage is higher than the reference voltage, turns off an open collector output of the comparator 31 considering that a power-supply voltage is being applied. On the other hand, when the output voltage is lower than the reference voltage, the comparator 31 turns on, for example, an open collector output considering that no power-supply voltage is being applied.

Accordingly, application of an output signal of the comparator 31 to the control electrode 41c of the

transistor 41 leads to cut-off of the second path B (see Fig. 2) for supplying a DC voltage to the physical layer 6 from the serial bus to supply an output of the power-supply circuit 2 to the voltage conversion means only when the comparator 31 detects a voltage.

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~~{Third Embodiment}~~

Next, a third embodiment of the present invention will be described with reference to Fig. 4.

Fig. 4 is a block diagram showing a node 100b, particularly, for explaining a structure of a bus power-supply device 10b constituting the node 100b according to the third embodiment. As shown in Fig. 4, the node 100b of the third embodiment is provided with a relay element 15 as a voltage detection means and a selection means. In the third embodiment, the same components as those of the first embodiment are given the same reference numerals and no detailed description is made thereof.

To a main body 15b of the relay element 15, a voltage is applied from a power-supply circuit 2. Accordingly, when a power-supply voltage is applied to the power-supply circuit 2, a voltage is also applied to the main body 15b of the relay element 15. As a result, supply of a power-supply voltage leads to displacement of the position of a relay contact point 15a. Displacement of the contact point 15a therefore results in switching of a DC voltage source to be applied to a

physical layer 6 between an internal power source and an external power source.

More specifically, when a power-supply voltage is applied, the contact point 15a cuts off a path for supplying power from power-supply terminals 81 and 91 and connects the power-supply circuit 2 and a DC-DC converter 5. On the other hand, when no power-supply voltage is applied, the contact point connects the power-supply terminals 81 and 91 with the DC-DC converter 5. With this arrangement, to a node having an internal power source, no power will be supplied from other nodes through the serial bus. It is accordingly possible to reduce the volume of power supply required of a node having the highest DC voltage on the network as much as that of a node having an internal power source among the nodes having the bus power-supply circuit according to the present invention.

Although the foregoing embodiments have been described with respect to an example in which the present invention is structured on specific conditions, the present invention allows various modifications. For example, although in the above-described second embodiment, the first path A (see Fig. 2) is conductive also at the time of non-application of a power-supply voltage, it may be cut off at the time of non-application in the present invention.

In addition, although the foregoing embodiments

have been described with respect to an example of a node having two connectors, the present invention can be realized by the provision of at least two connectors. Three or more connectors may be provided to relay a DC voltage or a signal between these connectors.

Moreover, although in a network connected by an IEEE-1394 Standard serial bus, it is desirable that all the nodes have the bus power-supply device according to the present invention, not all the nodes need to be provided with the bus power-supply device of the present invention. A part of the nodes on the network may include the bus power-supply device according to the present invention.

As described in the foregoing, the present invention enables relay of a DC voltage applied from a serial bus to other nodes, as well as enabling application of a DC voltage from other nodes to a physical layer to be prevented when a node has an internal power source. It is accordingly possible to reduce the volume of power supply required of a node having the highest DC voltage as much as that of a node having an internal power source.

Although the invention has been illustrated and described with respect to exemplary embodiment thereof, it should be understood by those skilled in the art that the foregoing and various other changes, omissions and additions may be made therein and thereto, without

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